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Pheromone-mask by the Female *Dendroctonus pseudotsugae* Hopk., an Attraction Regulator[1]

(Coleoptera : Scolytidae)

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A new phenomenon is described in which the female Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopk. (Coleoptera: Scolytidae), masks its own pheromone and rapidly stops the mass attraction of flying beetles; the stridulation of the male was found to trigger this masking. The effect of all pheromone including the residue in the frass is negated, but the primary attraction to host oleoresin and terpenes is not affected.

Earlier studies showed that unmated, sexually mature female beetles of this species feeding in the bark of the host tree produce an attractant that aggregates the population around the invaded tree (Rudinsky, 1961; McMullen and Atkins, 1962). Both sexes respond but in the ratio of two males to one female. The attracted females search for a suitable place to enter the bark and the males enter the individual female galleries and copulate, often some time later. At this point, the population aggregation to such a tree or log drops very suddenly. Since it is known that mating stops the pheromone production, the field methods used in earlier attraction studies (Rudinsky, 1963) were modified to eliminate mating as the act terminating the attraction.

Briefly, 30 sexually mature but unmated females were introduced into the bark of log sections and sealed off by a metal screen (mesh 24 × 24) to prevent entry of males but allow escape of volatile at-

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tractive substances and the normal falling of frass from galleries. The females produced the pheromone and attracted beetles in flight several hours after introduction. Field tests were made with live and killed males and females in various combinations and the changes in response of flying Douglas-fir beetles were noted.

When the attractive females were killed, their pheromone and its residue present in the frass were not masked although the introduced males stridulated as usual and remained over the entry holes of the dead females for four days. On the other hand, when the females remained alive the masking occurred rapidly after the introduced males stridulated. The mask was repeatedly interrupted and restored when the stridulating males were moved off and on the screen. Clearly the female masks her own attractant.

It was also clear that the male's stridulation on the screen triggered the masking action. As soon as the stridulation began, the attraction ceased and no additional beetles flew to the log. Males whose elytral declivity was clipped off exhibited normal arrestment behavior, as shown in previous studies by Jantz and Rudinsky (1965) except that they could not stridulate, and no mask occurred. Although stridulation is apparently the necessary trigger under normal conditions, the mask was induced without stridulation when these males with cut elytral declivity were allowed to enter unscreened entry holes of attractive females and mate there. Also, when normal males were allowed to enter the gallery, they no longer stridulated continuously but the mask, of course, remained.

The question arose whether the mask affects the known primary attraction to oleoresin and terpenes, especially alpha-pinene, camphene and limonene (Rudinsky, 1966a). The response to these substances was comparable to previous tests, however, and showed the usual ratio of one male to two females.

The speed of both the masking effect and the resumption of attraction must be emphasized. The mask was immediate after all females had been found by males. This is quantitatively striking because at peak flight 700–900 beetles per hour may be attracted before the mask. After the males were removed, attraction began again in eight minutes, at the earliest, and ten minutes, at the latest (68°F). This speed is essential to the regulating effect of the mask.

Essential also is the spatial relationship. Proximity appears to be a critical factor before the male responds to the female and begins to stridulate. The males released on the screened log crawled around and began to orient themselves to the females' entry hole and to

stridulate only when about ½ inch away. When two log sections, one with attractive females and the other with females joined by males (i.e. masked attraction), were placed six inches apart, only a few beetles were attracted and only to the unmasked attraction. Other logs attracted some flying beetles when part contained females joined by stridulating males and part did not. In another test males were introduced into holes and screened 2 inches from the entry holes of pheromone-producing females; they did not stridulate and the females did not mask the attractant. These tests indicate that the mask of each female is restricted to the area near its entry hole.

The survival value of this masking phenomenon is clear. Mating is assured because the virgin females attract twice as many males as females to the invaded host although the sex ratio in the natural population is 1 : 1 (Rudinsky, 1966b). The mask prevents the aggregation of unneeded males as well as their unnecessary exposure to predators, and since it stops the attraction of other females also it prevents too dense invasion of the host with resultant overcrowding and starvation of the brood. It is important also that the female can annul the mask quickly if the male should be destroyed before she is mated. The survival effect is also seen in relation to overcoming host resistance, i.e. since the mask is spatially limited, it does not prevent the mass invasion essential to killing the Douglas-fir tree (Rudinsky, 1966b). The fact that the attractiveness of oleoresin and terpenes is not masked assures optimal utilization of the host. This survival value suggests a new possibility of control of the most destructive bark beetle in Pacific Coast Douglas-fir stands through manipulation of the masking substance.

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